

Appl. No. 10/645,681
Examiner: NHU, DAVID, Art Unit 2818
In response to the Office Action dated April 29, 2004

Date: July 2, 2004
Attorney Dock t No. 10112791

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

Claim 1 (currently amended): A method for forming bottle-shaped trenches, suitable for use in a dynamic random access memory (DRAM), comprising:

- providing a substrate;
- forming a hard mask having openings on the substrate;
- etching the substrate through the openings to form trenches with ~~[[a]]~~ an upper portion and a lower portion;
- conformally forming ~~[[a]]~~ an isolated layer in the trenches and on the hard mask;
- forming a shield layer in the lower portion of the trenches;
- removing parts of the isolated layer which is not covered by the shield layer to expose the surface of the upper portion of the trenches;
- forming a protective layer on ~~the sidewall~~ sidewalls of the upper portion of the trenches;
- removing the shield layer to expose the isolated layer in the lower portion of the trenches;
- removing the isolated layer to expose the substrate of the lower portion of the trenches;
- and
- etching the substrate of the lower portion of the trenches using the protective layer as a mask to form bottle-shaped trenches.

Claim 2 (original): The method as claimed in claim 1, wherein the substrate comprises silicon.

Claim 3 (original): The method as claimed in claim 2, wherein the hard mask comprises a nitride.

Claim 4 (original): The method as claimed in claim 1, wherein the trenches are etched by an anisotropic etching.

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Claim 5 (original): The method as claimed in claim 1, wherein the isolated layer comprises an oxide.

Claim 6 (original): The method as claimed in claim 5, wherein the isolated layer is formed by chemical vapor deposition (CVD).

Claim 7 (original): The method as claimed in claim 1, wherein the protective layer further comprises dopants.

Claim 8 (original): The method as claimed in claim 7, wherein after forming the protective layer further comprises driving the dopants into the substrate surrounding the protective layer by thermal treatment.

Claim 9 (original): The method as claimed in claim 1, wherein the shield layer comprises polysilicon.

Claim 10 (original): The method as claimed in claim 8, wherein the step of forming a shield layer in the lower portion of the trenches comprises:

- forming the shield layer to fill the trenches;
- removing parts of the shield layer in the upper portion of the trenches to leave parts of the shield layer in the lower portion of the trenches.

Claim 11 (original): The method as claimed in claim 1, wherein the shield layer is formed by chemical vapor deposition (CVD).

Claim 12 (original): The method as claimed in claim 1, wherein the protective layer comprises a nitride.

Claim 13 (original): The method as claimed in claim 12, wherein the protective layer is formed by chemical vapor deposition (CVD).

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Claim 14 (currently amended): A method for forming bottle-shaped trenches, suitable for use in a dynamic random access memory (DRAM), comprising:

- providing a substrate;
- forming a hard mask having openings on the substrate;
- etching the substrate through the openings to form trenches with ~~[[a]]~~ an upper portion and a lower portion;
- conformally forming ~~[[a]]~~ an isolated layer in the trenches and on the hard mask;
- forming a shield layer in the lower portion of the trenches;
- removing parts of the isolated layer which is not covered by the shield layer to expose the surface of the upper portion of the trenches;
- conformally forming a protective layer on ~~the sidewall~~ sidewalls and the bottom of the trenches;
- removing parts of the protective layer on the bottom of the trenches to leave parts of the protective layer on the sidewall of the trenches;
- removing the shield layer to expose the isolated layer in the lower portion of the trenches;
- removing the isolated layer to expose the substrate of the lower portion of the trenches;
- and
- etching the substrate of the lower portion of the trenches using the protective layer as a mask so as to form bottle-shaped trenches.

Claim 15. (original): The method as claimed in claim 14, wherein the substrate comprises silicon.

Claim 16. (original): The method as claimed in claim 14, wherein the hard mask comprises a nitride.

Claim 17. (original): The method as claimed in claim 14, wherein the trenches are etched by an anisotropic etching.

Claim 18. (original): The method as claimed in claim 14, wherein the isolated layer comprises an oxide.

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Claim 19. (original): The method as claimed in claim 18, wherein the isolated layer is formed by chemical vapor deposition (CVD).

Claim 20. (original): The method as claimed in claim 14, wherein the protective layer further comprises dopants.

Claim 21. (original): The method as claimed in claim 20, wherein after formation of the protective layer, dopants are driven into the substrate surrounding the protective layer by thermal treatment.

Claim 22. (original): The method as claimed in claim 14, wherein the shield layer comprises polysilicon.

Claim 23. (original): The method as claimed in claim 14, wherein the step of forming a shield layer in the lower portion of the trenches comprises:

forming the shield layer to fill the trenches;

removing parts of the shield layer in the upper portion of the trenches to leave parts of the shield layer in the lower portion of the trenches.

Claim 24. (original): The method as claimed in claim 14, wherein the shield layer is formed by chemical vapor deposition (CVD).

Claim 25. (original): The method as claimed in claim 14, wherein the protective layer comprises a nitride.

Claim 26. (original): The method as claimed in claim 25, wherein the protective layer is formed by chemical vapor deposition (CVD).

Claim 27. (new): A method for forming bottle-shaped trenches, suitable for use in a dynamic random access memory (DRAM), comprising:
providing a substrate;

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forming a hard mask having openings on the substrate;
etching the substrate through the openings to form trenches with an upper portion and a lower portion;
conformally forming an isolated layer in the trenches and on the hard mask;
forming a shield layer in the lower portion of the trenches covered with the isolated layer;
removing parts of the isolated layer which is not covered by the shield layer to expose the surface of the upper portion of the trenches;
forming a protective layer on sidewalls of the upper portion of the trenches;
removing the shield layer to expose the isolated layer in the lower portion of the trenches;
removing the isolated layer to expose the substrate of the lower portion of the trenches;
and
etching the substrate of the lower portion of the trenches using the protective layer as a mask to form bottle-shaped trenches.